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# METHOD OF SIMULTANEOUSLY MOLDING DIFFERENT RAW MATERIALS
[Ishugenryo ni yoru douji seikeihoho]

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| TITLE | (54): METOD of SIMULTANEOUSLY MOLDING DIFFERENT RAW MATERIALS |
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Specification

1. Name of this Invention

METHOD OF SIMULTANEOUSLY MOLDING DIFFERENT RAW MATERIALS

2. Claims

[1] Method of simultaneously molding different raw materials by filling a raw material of foaming thermoplastic resin particles into a mold, heating and expanding said raw material by a heating medium such as vapor to obtain a molded foam, comprising: a first step, for providing a divider having spaces of uniform interval in the dividing direction at the boundary of mold sections to be filled with respective different raw materials; a second step, for filling different raw materials into assigned molding sections; and a third step, for withdrawing said divider from the mold before the completion of heat-fusion so as to form an integral mold having sections consisting of different raw materials.

[2] Method of simultaneously molding different raw materials according to the Claim 1, wherein, after different raw materials are filled in the sections created by the divider dividing the inside of the mold, the divider is withdrawn from the mold before initiating the heating process.

[3] Method of simultaneously molding different raw materials according to the Claim 1, wherein, after different raw materials are filled in the mold sections created by the divider dividing the

inside of the mold, the divider is withdrawn from the mold while the raw materials are heated.

[4] Method of simultaneously molding different raw materials according to the Claim 1, wherein said divider dividing the inside of the mold consists of an array (or arrays) of numerous pins provided at uniform distances.

[5] Method of simultaneously molding different raw materials according to the Claim 1, wherein the divider is comb-like shaped.

3. Detailed Explanation of this Invention

[Field of the Invention]

The present invention relates to a method of simultaneously molding different raw materials and is particularly associated with a method that can produce an integrally molded product comprising mold sections of at least two kinds of foaming thermoplastic resin particles without causing a mixture of those different materials.

[Prior Art]

When producing a foamed mold product, if certain sections of the mold need to provide specific characteristics (e.g., strength or chemical resistance), after such sections for meeting the specific requirements are separately molded using plurality of raw materials (foaming thermoplastic resin particles), the prepared molds are fitted or adhered to produce an integral foamed mold product. The drawbacks of this method are: (1) Consistent production of uniformly integrated mold products is not possible, as mold sections are

shifted during adhesion process and (2) the process requiring many operational steps is not efficient or productive, and therefore, not cost effective. For those reasons, an improved technique is needed by the industry.

This invention provides a method that can simultaneously mold different raw materials so as to eliminate the problems described above. That is, the present invention provides a method of simultaneously molding different raw materials by filling a raw material of foaming thermoplastic resin particles into a mold, heating and expanding said raw material by a heating medium such as vapor to obtain a molded foam, comprising: a first step, for providing a divider having spaces of uniform interval in the dividing direction at the boundary of mold sections to be filled with respective different raw materials; a second step, for filling different raw materials into assigned molding sections; and a third step, for withdrawing said divider from the mold before the completion of heat-fusion so as to form an integral mold having sections consisting of different raw materials.

Hereinafter, the embodiment of the present invention will be explained while referring to figures.

The reference numeral **1** denotes an overall cavity mold. The reference numeral **11** denotes a box frame used as an outer frame of the cavity mold **1**. The reference numeral **12** denotes a cavity part used as the inner mold of the cavity mold **1**, wherein said box frame

11 and cavity mold 12 are mounted with a bolt 13. The reference numeral 2 denotes a core mold. The reference numeral 21 denotes the box frame, which the outer frame of the core mold 2, and the reference numeral 22 denotes the core part used as the inner mold of the core mold 2, wherein the box frame 21 and core part 22 are mounted by a bolt 23. The cavity mold 1 and core mold 2 are specifically designed to form a mold section 3 (hollow part) when those mold sections 1, 2 are aligned and tightened so as to allow a raw material to be filled in the mold section 3. In this case, numerous pins 4 are provided along the boundary line of the mold section 3 in which a different raw material is to be filled in. Those pins 4 can be inserted into the holes 24 formed on the wall surface of said core part 22, while one end contacts or is positioned close to the inner wall surface 14 of the cavity 12 (a small space is allowed as long as it does not allow the foamed raw material to pass through), while the other end is connected to the mounting plate 41. This mounting plate 41 is mounted on the back of the core box frame 21 via a plunger 42, being able to move backward and forward by the operation of an applicable device such as air cylinder 43, so that the numerous pins functioning as dividers can be inserted into or withdrawn from the mold section 3. That is, when the air cylinder 43 moves forward, the tips of the pins contact (or are positioned close to) the inner wall 14 of the cavity 12 to provide a mold section 31. On the other hand, when the air cylinder 43 moves backward, the tips

of the pins **40** are positioned at the same level of the molding product surface **25** of the core **22**, or they slightly protrude from the surface **25** of the core **22** (if the mold product may contain slightly indented area, pins can slightly protrude from the mold product surface.)

The reference numerals **5** and **6** denote raw material filling devices mounted on the box frame **11** of the cavity mold **1**. The tip **51** of the filling device is connected to the mold section **3**, while the tip **61** of the filling device **6** is connected to the mold section **31** created by the divider consisting of pins **4**. Both filling devices contain plungers **52**, **62**, air suction inlets **53**, **54**, **63**, **64** for moving the plungers **52**, **62** in the backward and forward directions, raw material inlets **56**, **66**, and forced air inlets **56**, **66**.

The reference numeral **16** in the figure denotes a vapor supply hole for the cavity mold, and the reference numeral **17** denotes a cooling water supply hole. The reference numeral **18** denotes a drain exhaust hole. The reference numeral **26** denotes a vapor supply hole for the core mold. The reference numeral **27** denotes a cooling water supply hole. The reference numeral **28** denotes a hole for draining the exhaust water.

The diameter (b) of each pin **4** used as a part of divider is approx. 1 $mm^{\Phi}$ - 10 $mm^{\Phi}$. The pins are not limited to circular pins, as square pins of approx. same sizes can be used. The space (a) between pin **4** and pin **4** is made narrower than the particle diameter (size) of

one of different raw materials, or it is made narrower than the particle diameters of both different raw materials.

The following explains the steps for simultaneously molding different raw materials using the device configured as described above. Note that the steps described below will be explained based on the case when the particle diameter of the raw material injected into the mold section **3** is smaller than the particle diameter of the raw material injected into the mold section **31** partitioned by pins **4**, and the space between pins **4**, **4** is narrower than the particle diameter of the raw material put in the mold section **3**: After the cavity mold section **1** and core mold section **2** are fitted, pins are pushed forward by the air cylinder **43** mounted on the back of the box frame **21** of the core mold **2** so as to create mold sections **3** and **31**. Then, air is fed from the air inlet opening **63** of the filling device **6** provided for the mold section **31**, forcing the plunger **62** to withdraw. Then, one of two different raw materials is filled in the mold section **31** from the raw material supply inlet **65** by sending air through the air booster **66**. Next, the other raw material is filled in the mold section **3** using the other filling device **5** by the same mechanism described with the filling device **6**.

After different raw materials are completely filled in respective mold sections, the divider consisting of numerous pins **4** are withdrawn by operating the air cylinder **43**. Then, vapor is supplied through the vapor supply holes **16**, **26** to heat and expand raw

materials comprising respective kinds of foaming thermoplastic resin particles to fuse the two molds. Next, after cooling water is supplied from the cooling water supply holes **17**, **27** to cool the molds, the mold frames are removed to complete the mold production process.

Note that, instead of withdrawing pins **4** before heating the raw materials, pins **4** can be withdrawn when the raw materials are slightly fused by the heat.

On the other hand, when the particle diameter of the raw material to be filled in the mold section **3** is larger than the particle diameter of the raw material to be filled in the mold section **31**, the filling sequence described above is reversed so as to allow the filling device **5** to be operated first. When the space between pins **4**, **4** is smaller than the particle diameters of both kinds of raw materials filled in the mold sections **3**, **31**, the filling devices **5**, **6** may be simultaneously operated.

The molding method of this invention as described above does not limit the location of the divider consisting of pins **4** to the center of the molding product, as it may be any corner area of the mold product. Also, instead of providing an enclosed area, pins **4** may be arranged to provide a piece of dividing plate, or they may be arranged to provide plural dividers. Furthermore, a comb-like divider (not shown in the figure) having uniformly spaced teeth, similar to the pin structure, may be used instead of pins **4** for

producing the same result.

When the divider consisting of pins **4** or the like is positioned at the core side **2**, while raw material filling devices **5**, **6** are positioned at the cavity side **1**, allowing the divider **4** can be positioned opposing to the filling devices **5**, **6** over the mold sections **3**, **31**, not only the molding production can be effectively operated, but also spaces can be efficiently utilized.

In addition, instead of the air cylinder **43**, any other applicable device may be used to operate the pins **4**.

The difference of the raw materials described in this invention may be ① particle diameters, ② foaming multiplications, ③ material substances, or ④ colors. An example of the difference ③ is foaming type polystyrene type resin particles used as one material and foaming type polyethylene type resin particles used as the other material.

Hereinafter, an operational example of the present invention will be explained.

A molding section (3) (3 liters in volume) and molding section (31) (0.3 liters in volume) were provided to form a rectangular type mold having average thickness of 30 mm (see Figs. 4 and 5). The raw material for the mold section (3) was foaming polystyrene resin particles (particle diameter = 2.0 - 5.0 mm) pre-foamed to 50 times in volume. The raw material for the mold section (31) was foaming type polyethylene resin particles (particle diameter = 3.2 - 7.0 mm)

pre-foamed to 30 times in volume. The diameter (b) of the pin (4) was 3 $mm^{\phi}$, and the space (a) between pins was 3 mm. In this configuration, the foaming type polyethylene resin particles were filled prior to filling the foaming polystyrene resin particles under the following operational conditions: Raw material filling duration = 19 seconds; mold-heating duration = 12 seconds; pressure of hot vapor = 0.4 $Kg/cm^3$ provided for a duration of 10 seconds; 0.85 $Kg/cm^3$ for a duration of 20 seconds; forced cooling duration = 35 seconds; natural cooling duration = 20 seconds; and withdrawal of pins (4) = during heating process. As a result, although different materials were simultaneously molded, sufficient bonding strength was provided to the boundary of those two different materials with a clear separation line at the boundary of two materials.

As described above, the present invention provides a divider containing plural spaces uniformly made in the dividing direction for creating a boundary of two different molding raw materials. After the mold sections created by the divider are filled with respective raw materials, the divider is withdrawn before the completion of heat-hardening process so as to produce a fused mold consisting of integrated two different raw materials. As a result, the foamed mold can have a clear boundary to the two kinds of foaming thermoplastic resin particles without causing the mixture of particles. Therefore, various mold configurations according to required product functions (e.g., mold having a reinforced section, mold having a chemical

resistant section, or mold having a section with added values) can be easily produced.

Furthermore, the simultaneous molding method of the present invention does not require separate molding of individual material or insertion/adhesion of separately molded sections. In addition, as the produced mold product can completely integrate mold sections consisting of different raw materials, the mold-section boundary area can provide increased strength. As a result, the increased boundary strength can compensate for forming a thinner mold. The simultaneous molding process of the present invention can reduce the cost of molds and molding process, thereby allowing the related field to obtain significant advantages.

4. Simple Explanation of the Drawings

Figure 1 is a cross-sectional diagram of the device of the present invention, when different raw materials are filled. Figure 2 is a cross-sectional diagram of the device of the present invention, showing the condition when materials are heat-fused and molded. Figure 3 is a diagram showing the enlarged section A in Fig. 2. Figure 4 is a diagram showing an example of foamed mold product produced by the present invention. Figure 5 is a cross-sectional diagram of the product shown in Fig. 4.

1…Cavity type; 2…Core type; 3, 4…Mold section; 4…Pin; 5, 6…Different raw material filling device; 100…Foamed mold product; 100'…Boundary area.

Figure 1

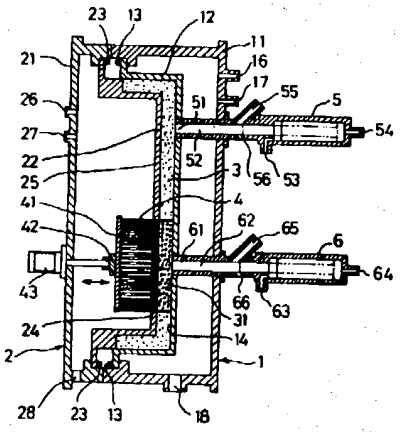


Figure 2

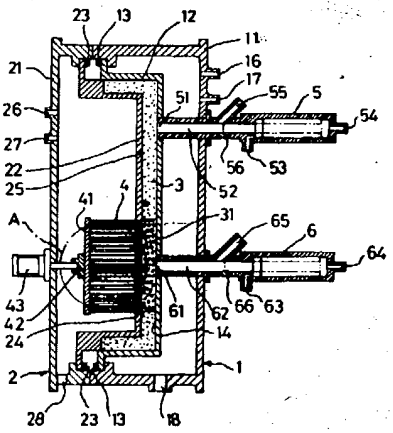


Figure 3

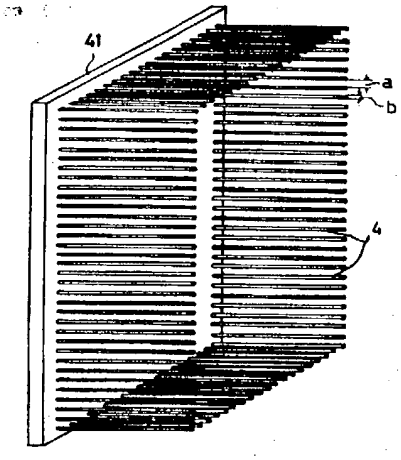


Figure 4

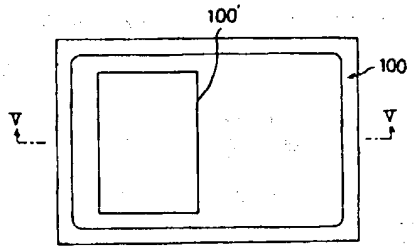


Figure 5